1- $D_e = 21.905$ mm, $P = 3$ mm, $\Delta P_{max} = 0.025$ mm, $\delta\theta_R = 5'$, $\delta\theta_L = 6'$, ISO thread

$\Delta P = \Delta P_{max} \cdot \cot\theta_{std} = 0.025 \cot 30^\circ = 0.043$ mm

$\Delta\theta = 0.0131 P_{std} (\delta\theta^\circ_R + \delta\theta^\circ_L) = 0.0131(3)\left(\frac{5}{60} + \frac{6}{60}\right) = 0.007$ mm

$V.E.D = D_e + \Delta P + \Delta\theta = 21.905 + 0.043 + 0.007 = 21.955$ mm

2- MS2XS, $R_{cyl.} = 25.0033$ mm, $D_{cyl.} = 15.0030$ mm, $(2d)_1 = 13.2007$ mm,

$(2d)_2 = 13.2002$ mm, $(2d)_3 = 13.2$ mm, $S_1 = 64.0272$ mm, $S_2 = 64.0270$ mm, $S_3 = 64.0275$ mm

- Zero error $= R_{cyl.} - D_{cyl.} = 25.0033 - 15.0030 = 10.0003$ mm

- $(2d)_{av.} = \frac{\sum_{i=1}^{3} (2d)_i}{3} = \frac{13.2007 + 13.2002 + 13.2}{3} = 13.2003$ mm

$2d = (2d)_{av.} - \text{zero error} = 13.2003 - 10.0003 = 3.2$ mm

$d = \frac{2d}{2} = 1.6$ mm

- $S_{av.} = \frac{\sum_{i=1}^{3} S_i}{3} = \frac{64.0272 + 64.027 + 64.0275}{3} = 64.0272$ mm

$S = S_{av.} - \text{Zero error} = 64.0272 - 10.0003 = 54.0269$ mm

- $D_e = S - d(1 + \text{cosec}\theta_{std}) + \frac{P_{std}}{2}\cot\theta_{std} = 54.0269 - 1.6\left(1 + \frac{1}{\sin 30^\circ}\right) + \frac{3}{2\tan 30^\circ}$

$D_e = 53.5570$ mm

- $T = S - 2d = 54.0269 - 3.2 = 50.8269$ mm

$A = \frac{d}{T + d} = \frac{1.6}{50.8269 + 1.6} = 0.0305$ mm

- $e = \frac{\cos\theta\cot\theta}{2\pi^2} \times \frac{L^2}{d} \times A^2(1 + A\sin\theta + A^2\sin^2\theta)$

$e = \frac{\cos 30^\circ}{2\pi^2 \tan 30^\circ} \times \frac{S^2}{1.6} \times (0.0305)^2 \left[1 + 0.0305\sin 30^\circ + (0.0305)^2(\sin 30^\circ)^2\right]$

$e = 0.0011$ mm

- $D_{e_e} = D_e - e = 50.9590 - 0.0011 = 50.9579$ mm

$C = 0.001 \frac{Fe^{2/3}}{D_{e_e}^{1/3}} = 0.001 \frac{(2.45)^{2/3}}{(50.9579)^{1/3}} = 0.0005$ mm

- $D_{corrected} = D_e - e + C = 50.9590 - 0.0011 + 0.0005 = 50.9584$ mm

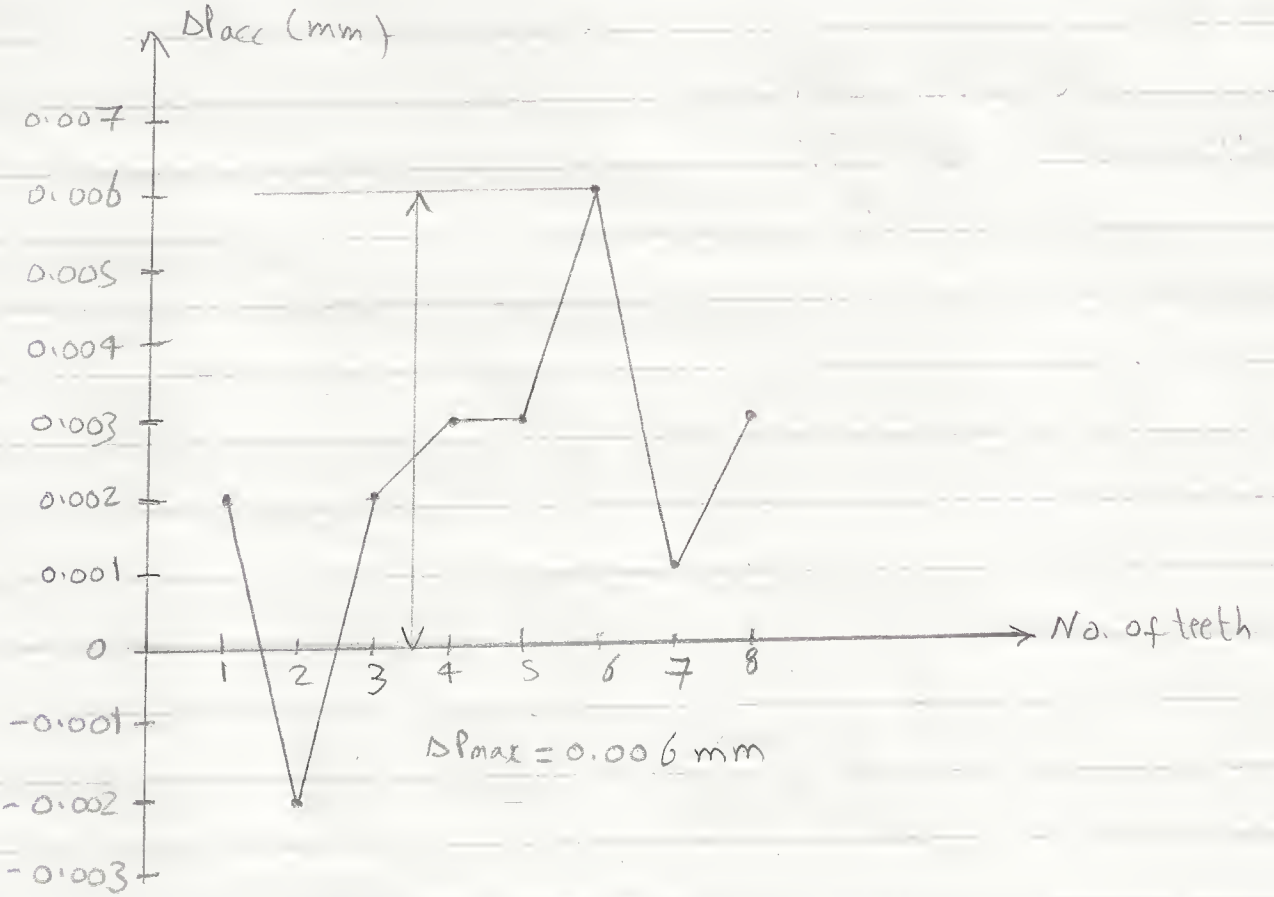
3- M16X1.5, S = 17.019 mm, d = 1.35 mm, $\theta_L = 29.5°$, $\theta_R = 30.5°$

P_i (mm)	1.502	1.496	1.504	1.501	1.500	1.503	1.495	1.502

Nut : $14.260^{\pm 0.035}$ mm

- $\Delta P = P_i - P_{std} = P_i - 1.5$

ΔP_i (mm)	0.002	-0.004	0.004	0.001	0	0.003	-0.005	0.002
$\Delta P_{accumulated}$ (mm)	0.002	-0.002	0.002	0.003	0.003	0.006	0.001	0.003



$\Delta D_{e_p} = \Delta P_{max} \cot\theta_{std} = 0.006 \cot 30° = 0.010$ mm

- $\delta\theta = \theta - \theta_{std}$

$\delta\theta_L = 29.5° - 30° = -0.5°$

$\delta\theta_R = 30.5° - 30° = 0.5°$

$\Delta D_\theta = 0.0131\, P_{std} (|\delta\theta_L| + |\delta\theta_R|) = 0.0131(1.5)(0.5+0.5) = 0.020$ mm

- $D_e = S - d(1 + \cos\sec\theta_{std}) + \frac{P_{std}}{2}\cot\theta_{std} = 17.019 - 1.35(1+\cos\sec 30°) + \frac{1.5}{2}\cot 30°$

$D_e = 14.268$ mm

V.E.D. $= D_e + \Delta D_{e_\theta} + \Delta D_{e_p} = 14.268 + 0.020 + 0.010 = 14.298$ mm

- For nut $D_{e_{min}} = 14.26 - 0.035 = 14.225$ mm

$D_{e_{max}} = 14.26 + 0.035 = 14.295$ mm

$D_e + \Delta D_{e_\theta} = 14.268 + 0.020 = 14.288$ mm

$D_{e_{max}} > D_e + \Delta D_{e_\theta} > D_{e_{min}}$ & V.E.D. $> D_{e_{max}} \Rightarrow$ Nut Partially fits

$D_e = 14.268\,mm$, $D_{emin} = 14.225\,mm$, $D_{emax} = 14.295\,mm$

i	1	2	3	4	5	6	7	8
$\Delta D_{epacc,i}$ (mm)	0.003	-0.003	0.003	0.005	0.005	0.010		
$\Delta D_{e\Theta} = 0.02$ mm								
V.E.D$_i$ (mm)	14.291	14.285	14.291	14.293	14.293	14.298		

$V.E.D._6 > D_{emax} \Rightarrow$ Nut partially fits at 5 teeth

4- $d = 1.35$ mm, M16X2, S.V $= 0.01$ mm, $R_{zero} = 0.05$ mm, $All._{max\ per.} = 0.021$ mm

$All._{min\ per.} = 0$

$D_e = D_o - h = D_o - 0.866P = 16 - 0.866 \times 2 = 14.268$ mm

$S = D_e + d(1 + \csc(\theta)) - \frac{P}{2}\cot\theta = 14.268 + 1.35(1 + \csc 30^\circ) - \frac{2}{2\tan 30^\circ} = 16.586$ mm

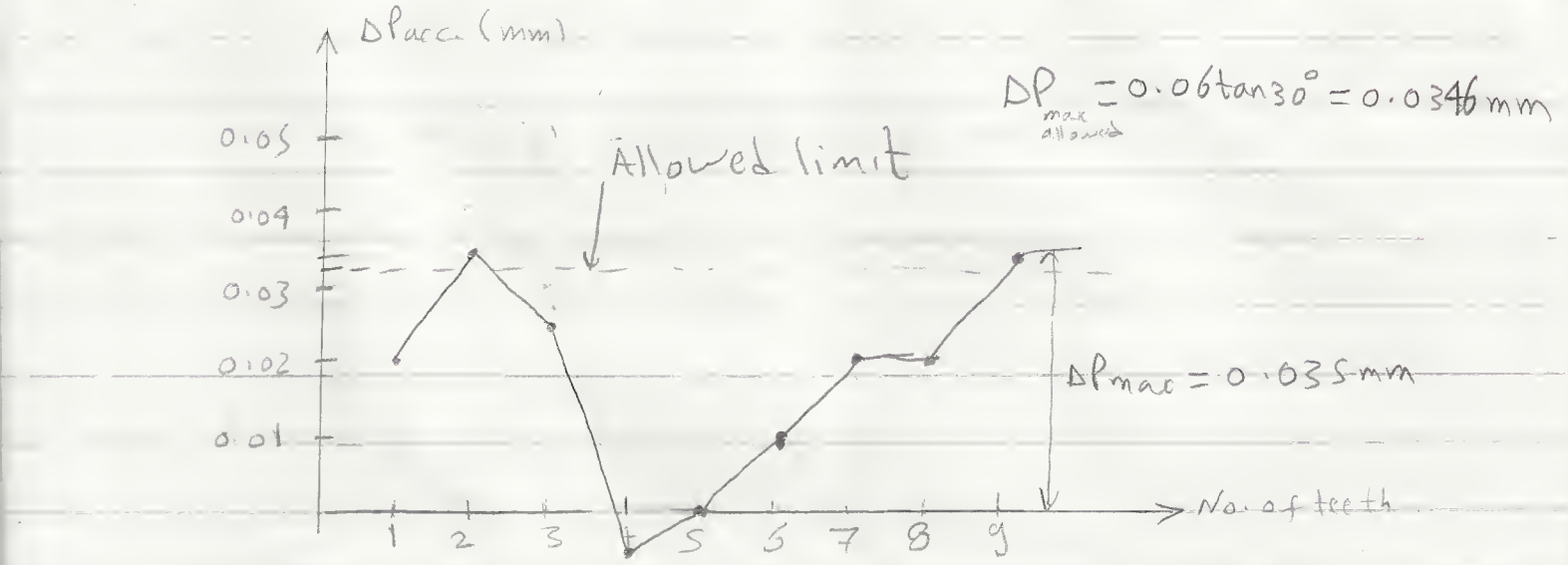
Reading $= S + R_z + All$

$R_{min} = 16.586 + 0.05 + 0 = 16.636$ mm

$R_{max} = 16.586 + 0.05 + 0.021 = 16.657$ mm

5- $Allowance_{nut} = \pm 0.06$ mm; S.V. doesn't affect analysis approximation

i	1	2	3	4	5	6	7	8	9
$P_{i_{1st}}$ (mm)	2.02	2.01	1.98	1.97	1.98	2.04	2.02	1.96	2.03
$P_{i_{2nd}}$ (mm)	2.02	2.02	2.00	1.97	2.03	1.98	2.00	2.04	2.00
$P_{i_{av.}}$ (mm)	2.02	2.015	1.99	1.97	2.005	2.01	2.01	2.00	2.015
Nominal pitch $= 2$ mm (from reading) $\Rightarrow \Delta P = P_i - P_{std} = P_i - 2$									
ΔP_i (mm)	0.02	0.015	-0.01	-0.03	0.005	0.01	0.01	0	0.015
$\Delta P_{acc.}$ (mm)	0.02	0.035	0.025	-0.005	0	0.01	0.02	0.02	0.35



$\Delta P_{max\ allowed} = 0.06\tan 30^\circ = 0.0346$ mm

$\Delta D_{e_{max}} = \Delta P_{max}\cot\theta = 0.05\cot 30^\circ = 0.09$ in mm

$\Delta D_{e_{max}} > All_{max} \Rightarrow$ Nut partially fit at 1 tooth

No. of teeth of nut $= \frac{H}{P} = \frac{10}{2} = 5$